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Original communication

Analysis of the hematological and biochemical parameters related to lead intoxication

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ABSTRACT

In parallel with industrial advancements, number of the occupational diseases secondary to chemical exposure is increasing. The chemical agents in the work places affect various organ and tissue systems, leading to chronic diseases. In this study, the cases diagnosed with occupational disease due to exposure to lead were studied and importance of the environmental forensic sciences on this issue was emphasized. A hundred and ninety patients diagnosed with occupational disease related to lead intoxication in Ankara Occupational Diseases Hospital between 01/01/2009 and 31/12/2009 were included in the study. Twenty cases were used as the controls. Sociodemographic characteristics, serum chemical parameters and hematological parameters of the patients were retrospectively assessed. Mean age of the cases included in the study was 35.3 ± 8.69. Hemoglobin (Hb) ($p = 0.018$) and Mean corpuscular volume (MCV) ($p < 0.001$) values were found significantly lower in the patients with lead exposure than in the controls. Gamma glutamyl transferase (GGT) was significantly lower in the patients with lead exposure than in the controls ($p = 0.002$), whereas alkaline phosphatase (ALP) was found higher ($p < 0.001$). In thyroid function test (TFTs) panel, free triiodothyronine (fT3) levels were found significantly higher in the patients with lead exposure than in the control group ($p = 0.01$), while Thyrotrophin-stimulating hormone (TSH) levels were lower ($p < 0.001$). No significant difference was found in terms of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) values. In the correlation analysis; serum level of serum lead (Pb) was correlated positively with ALP values and negatively with Hb, MCV and TSH. Considering its effects on the biochemical and hematological parameters, a detailed investigation should be carried out in the cases with lead exposure, which occupies an important place among the occupational diseases.

1. Introduction

In parallel with industrial advancements, number of the occupational disease secondary to chemical substance exposure is increasing. The chemical agents exposed in the work places affect various organ and tissue systems, leading to chronic diseases. Today, lead that is widely found in the nature and has an increasing use with the industrial advancements is used in printing, rubber, batteries, ceramics, dye, porcelain manufacturing, accumulator industry and as a gasoline additive.[1] Especially, the workers of these industrial branches, persons exposed to lead environmentally develop disorders in the functions of vital organs such as brain and kidneys related to the toxic impact of lead.[2]

Environmental Forensic Toxicology is a newly emerging branch and provides an essential scientific approach to both occupational and environmental lead exposure. Lack of preventive measures, insufficient labor inspection and uncontrolled industrial emissions are threats of human health.

In this study, we aimed to evaluate the biochemical and hematological parameters of the cases related to lead exposure and to emphasize the importance of occupational lead exposures in terms of the environmental forensic sciences.

2. Material & methods

A hundred and ninety patients diagnosed with occupational disease related to lead intoxication in Ankara Occupational Diseases Hospital between 01/01/2009 and 31/12/2009 were

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Table 1
Biochemical and hematological parameters of the patient and control groups with respective *p* values.

Parameters assessed	Patient group ($n = 190$) Mean ± SD	Control group ($n = 20$) Mean ± SD	*p*
Age	35.3 ± 8.69	43.9 ± 7.46	<0.001
Pb (ug/dL)	44.0 ± 16.9	3.29 ± 0.52	<0.001
Hb (g/dL)	14.8 ± 1.34	15.5 ± 0.99	0.018
MCV (f/L)	83.9 ± 5.53	90.7 ± 3.49	<0.001
AST (U/L)	22.8 ± 19.2	23.8 ± 5.85	0.052
ALT (U/L)	25.6 ± 19.3	24.0 ± 6.57	0.25
GGT (mg/dL)	28.7 ± 18.2	31.9 ± 4.89	0.002
fT3 (pmol/L)	2.88 ± 0.49	2.52 ± 0.45	0.01
fT4 (pmol/L)	1.20 ± 0.22	1.21 ± 0.16	0.69
TSH (mU/mL)	1.76 ± 1.02	3.02 ± 0.21	<0.001
ALP (IU/L)	82.8 ± 18.1	55.0 ± 22.0	<0.001

included in the study. Twenty cases were used as the controls. File records of all the cases were examined. Patients' sociodemographic characteristics and serum chemical parameters (Pb, ALT, AST, GGT, fT3, free thyroxine [fT4], TSH, ALP) and hematological parameters (Hb and MCV) were retrospectively evaluated. Patients who have a diagnosis which can effect the studied parameters were excluded.

Comparison of the data between the patient and control groups was performed using Mann–Whitney *U* test. The limit of significance was taken as $P < 0.05$. Correlation between the parameters was evaluated with Pearson's correlation analysis. All the statistical analyses were performed using SPSS 13.0 software.

3. Results

3.1. Sociodemographic data

The cases included in the study were in range of 21–70 years old with a mean age of 35.3 ± 8.69 years. Of the patients, 188 were males and 2 were females. Hospitalization durations were in the range of 1–37 days with a mean duration of 14 days. The patients were detected to be previously hospitalized for 1–6 times with the diagnosis of occupational disease.

3.2. Hematological data

Hb values were found significantly lower in the lead exposure group than in the controls ($p = 0.018$). Similarly; MCV values were also found statistically significantly lower in the patient group than in the controls ($p < 0.001$) (Table 1).

3.3. Biochemical data

On evaluation of the biochemical data, GGT was significantly lower in the patients with lead exposure than in the controls ($p = 0.002$), whereas ALP was found higher ($p < 0.001$). In TFT panel, fT3 levels were found significantly higher in the patients with lead exposure than in the control group ($p = 0.01$), while TSH levels were lower ($p < 0.001$) (Table 1).

On comparison of the patient group with the controls, no significant difference was found in terms of ALT and AST values.

In the correlation analysis carried out to evaluate the cases; serum level of Pb was correlated positively with ALP values and negatively with Hb, MCV and TSH (Table 2).

4. Discussion

Although lead exposure affect numerous systems causing encephalopathy, peripheral neuropathy, anemia, renal dysfunction and hepatic dysfunction, lead is still used in many industrial branches, especially in accumulator industry, ceramics, metal and dye industry.[3–7] Lead exposure caused by this lead usage produces several changes in hematological and biochemical parameters.

World Health Organization (WHO) considers a blood concentration of Pb over 40 μg/dL to be sufficient for the diagnosis of lead exposure,[8] while Center for Disease Control and Prevention set the safe limit as 25 μg/dL for the diagnosis.[9] In this study, mean serum values of Pb in the cases with occupational lead exposure were found as 44.0 ± 16.9 μg/dL. In a study by Hernandez et al. with 553 cases, these values were found as 43.8 μg/dL.[10] These values are over the limits. Furthermore, while the blood value of lead was 3.29 μg/dL in the control group of our study, it was defined as 3.65 and 3.13 μg/dL in the other studies conducted in Turkish population.[11,12]

In our study, mean values of hemoglobin and MCV were defined as 14.8 ± 1.34 g/dL and 83.9 ± 5.53 g/dL; respectively, in the patients group. These values were significantly lower compared to the controls group. Similarly, in the study by Pala et al., Hb and MCV values were also found lower.[13] A significantly negative correlation was found in our study between the blood levels of lead and the levels of Hb and MCV. Furthermore, in the previous studies, a negative correlation was demonstrated between the blood values of Pb and the values of Hb and MCV.[13,14]

Lead exposures are known to have obvious effects both on the thyroid function tests and TSH levels depending on the impairment of balanced functioning of the pituitary–thyroid axis.[15,16] On evaluation of the thyroid function tests in our study, fT3 values was found significantly higher and TSH values lower in the patient group than in the controls. TSH values were demonstrated to be positively correlated with the blood levels of Pb. In a study by Dündar et al. fT4 values were significantly lower, while no difference was found in our study.[17] In the conducted studies, fT3 values were shown to be higher and a positive correlation existed between TSH and the levels of lead.[15,16]

In our study, ALT and AST values were found as 25.6 ± 19.3 U/L and 22.8 ± 19.2 U/L; respectively. No statistical significance was defined on comparison with the controls group. Likewise, in a study by Orisakwe et al., a significant difference could not be demonstrated between the patient and control groups although there was a slight increase in ALP, ALT and AST levels.[18] In our study, ALP values were significantly higher in patient group and there was a significant positive correlation between Pb and ALP levels. In some studies, a positive correlation was found between the levels of GGT and the blood values of Pb, although in our study the levels of GGT were found significantly lower in the patients group, and no correlation was found with the blood levels of Pb.[19]

Table 2
Correlation table.

		Hb**	MCV**	AST	ALT	GGT	fT3	fT4	TSH**	ALP**
Pb	R^2	−0.245	−0.292	−0.055	−0.039	0.013	0.123	0.082	−0.216	0.193
	p	0.000	0.000	0.425	0.577	0.853	0.097	0.267	0.003	0.005

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

5. Conclusion

Occupational diseases are preventable. To achieve this, working instructions with the chemicals should be completely followed, and the audits need to be performed carefully. In addition, periodic health checks should be carried out, and necessary steps should be immediately taken in cases of the signs and symptoms for the exposure. The concentration levels of dangerous chemicals should be reduced, and collaboration should be made with the institutions working on this issue. Considering its effects on the biochemical and hematological parameters, a detailed investigation should be carried out in the cases with lead exposure, which occupies an important place among the occupational diseases.

Contributorship statement

All authors included in the authors list have contributed to the data collection, data evaluation, writing of manuscript, language use and etc. And no professionals other than authors contributed to the any process of during article preparation.

Ethical approval

No ethical approval was needed since used data was retrospectively evaluated without identifying patients.

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Competing interest statement

None declared.

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